

## PATENT ABSTRACTS OF JAPAN

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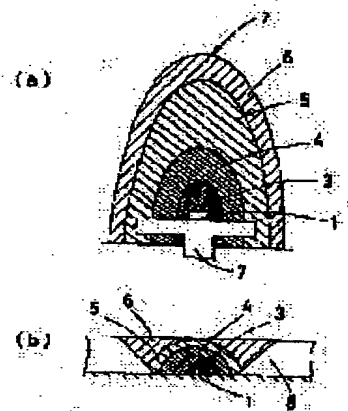
## (54) LIGHT-EMITTING DIODE

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To suppress loss of optical flux from the inside of a semiconductor of a light-emitting element, allowing effective guiding of the flux to the outside of a sealing resin.

**SOLUTION:** Related to a light-emitting diode where a light-emitting element 1 is sealed, the light-emitting element 1 is enclosed with an insulating high-refractive material (DLC3) whose refractive index is at least higher than that of an epoxy resin 5, so that no gap is formed with the light-emitting

element 1. Here, the refractive index of material is decreased as one proceeds outward, forming an optically gradient functional film 2 comprising a refractive index which changes continuously or stepwise. Thus, the difference in the refractive index can be decreased between a semiconductor forming the light-emitting element 1 whose refractive index is very high and the material contacting the light-emitting element 1. So, the total reflection is difficult to occur with the light from the inside of a semiconductor, allowing the light from the light-emitting element 1 to be effectively guided outside, for improved total light flux quantity.



(c) 図面番号: 2001-203392  
エポキシ樹脂  
高屈折率  
1-発光素子部 2-高屈折率材料層  
3-半導体部 4-電極部  
5-封止樹脂 6-反射層

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**CLAIMS**


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**[Claim(s)]**

[Claim 1] Light emitting diode characterized by forming an optical inclination functional film with a refractive index which is gradually [ continuously or ] different by making the refractive index of material low as a refractive index is higher than an epoxy resin at least, the aforementioned light-emitting-device section is surrounded with high refraction material with an insulating property and it goes outside so that it may be the light emitting diode which closed the light-emitting-device section and a crevice may not be formed between the aforementioned light-emitting-device sections.

[Claim 2] Light emitting diode characterized by the refractive index having been high, having been the light emitting diode which closed the light-emitting-device section, having surrounded the aforementioned light-emitting-device section with high refraction material with an insulating property rather than the epoxy resin at least so that a front face might be touched, and forming the periphery section with the material of a refractive index lower than the aforementioned quantity refraction material.

[Claim 3] It is the light emitting diode characterized by having at least one-fold [ of this low refraction material ] or more while being the light emitting diode which closed the light-emitting-device section by the resin and applying a low refraction material at least with a refractive index lower than a closure resin to a closure resin front face, and an outside making a refractive index low.

[Claim 4] High refraction material is light emitting diode according to claim 1 or 2 which is DLC.

[Claim 5] Light emitting diode according to claim 2 in which the epoxy resin was formed on the outside of high refraction material.

[Claim 6] Light emitting diode according to claim 1 which carried out the laminating of the titanium-chloride, epoxy resin, and magnesium fluoride to the outside of high refraction material.

[Claim 7] Light emitting diode according to claim 1 which made the optical inclination functional film the lens configuration.

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[Translation done.]

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## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the light emitting diode which has the closure structure which raises the drawing efficiency of light from the light-emitting-device section.

[0002]

[Description of the Prior Art] The conceptual diagram showing the shell type light emitting diode of the former [drawing 5], the respective diagram in which drawing 6 (a) shows the conventional module type light emitting diode, and (b) are the important section expanded sectional view. As shown in drawing 5, at the conventional light emitting diode, the light-emitting-device section 50 is closed by the epoxy resin 51. Moreover, in drawing 6, the light-emitting-device section 50 is arranged to opening of the reflective frame 52, and it is closing by the epoxy resin 51.

[0003]

[Problem(s) to be Solved by the Invention] However, in the above-mentioned conventional light emitting diode, since the refractive index of the semiconductor which forms the light-emitting-device section 50 was very large and the difference with the refractive index of the closure material (epoxy resin) which is in contact with the light-emitting-device section 50 was large, about luminescence inside a semiconductor, it was easy to produce total reflection, and the low fault had the drawing efficiency of the flux of light. Moreover, total reflection of what has a bigger light injected out of an epoxy resin than a certain angle was carried out, and it had produced loss inside.

[0004] Therefore, the purpose of this invention is offering the light emitting diode which derives effectively the light side taken out from the element the light emitting diode closure structure for suppressing loss of the flux of light from the interior of a semiconductor of the light-emitting-device section, and at once to the closure resin exterior in consideration of the above conventional troubles.

[0005]

[Means for Solving the Problem] The optical inclination functional film with a refractive index which be gradually [continuously or] different by make the refractive index of material low as a refractive index be higher than an epoxy resin at least, and the aforementioned light emitting device section be surround with high refraction material with an insulating property and it go outside so that the light emitting diode of this invention according to claim 1 may be the light emitting diode which closed the light emitting device section and a crevice may not be form between the aforementioned light emitting device sections in order to solve the above-mentioned technical problem be formed.

[0006] If the refractive index of the semiconductor which generally constitutes the light-emitting-device section is very high and the matter which has touched has a low refractive index, a critical angle will also be small and total reflection will tend to happen. Therefore, by wrapping the light-emitting-device section in the matter with a more high refractive index, the angle to which total reflection happens can be enlarged and the flux of light drawing efficiency to the part exterior improves.

[0007] In a claim 1, a refractive index is higher than an epoxy resin at least so that a crevice may not be formed between the light-emitting-device sections. Since the optical inclination functional film with a refractive index which is gradually [continuously or] different by making the refractive index of material low was formed as the aforementioned light-emitting-device section was surrounded with high refraction material with an insulating property and it went outside. A difference with the refractive index of the material which is in contact with a semiconductor with the very big refractive index which forms the light-emitting-device section, and the light-emitting-device section can be made small. For this reason, the light which it is hard coming to generate total reflection about the light which comes from the interior of a semiconductor outside, and comes out from the light-emitting-device section can be effectively led to the exterior, and the amount of total luminous fluxs improves.

[0008] At least, light emitting diode according to claim 2 was the light emitting diode which closed the light-emitting-device section, and rather than the epoxy resin, with the high refraction material which a refractive index is high and has an insulating property, it surrounded the aforementioned light-emitting-device section so that a front face might be touched, and it formed the periphery section with the material of a low refractive index from high refraction material.

[0009] Thus, a difference with the refractive index of the material which is in contact with a semiconductor with the very big refractive index which forms the light-emitting-device section, and the light-emitting-device section from the epoxy resin at least since the light-emitting-device section was surrounded with the high refraction material which a refractive index is high and has an insulating property so that a front face might be touched, and the periphery section was formed with the material of a refractive index low rather than high refraction material can be made small. For this reason, the light which it is hard coming to generate total reflection about the light which comes from the interior of a semiconductor outside, and comes out from the light-emitting-device section can be effectively led to the exterior, and the amount of total luminous fluxs improves.

[0010] Light emitting diode according to claim 3 was the light emitting diode which closed the light-emitting-device section by the resin, while applying a low refraction material at least with a refractive index lower than a closure resin to the closure resin front face, it has at least on -fold [of this low refractive index material] or more, and the outside made the refractive index low.

[0011] Thus, while applying a low refractive index material at least with a refractive index lower than a closure resin to a closure resin front face, since it has at least one fold or more and the outside made the refractive index low, this low refraction material can inject now to the exterior more light which was carrying out total reflection to the exterior air layer by the interface of a closure resin, and its amount of total luminous flux improves.

[0012] In claims 1 or 2, the high refractive index material of light emitting diode according to claim 4 is DLC. Thus, since high refractive index material is DLC (Diamond Like Carbon), it can be used as a material in which a refractive index has insulation highly.

[0013] Light emitting diode according to claim 5 formed the epoxy resin in the outside of high refraction material in the claim 2. Thus, since the epoxy resin was formed in the outside of high refraction material, the light which comes out from the light-emitting-device section can be led outside effectively.

[0014] Light emitting diode according to claim 6 carried out the laminating of the titanium-chloride, epoxy resin, and magnesium fluoride to the outside of high refraction material in the claim 1. Thus, a refractive index can be made low as it goes outside, since the laminating of the titanium-chloride, epoxy resin, and magnesium fluoride was carried out to the outside of high refraction material, and the light which comes out from the light-emitting-device section can be drawn outside effectively.

[0015] Light emitting diode according to claim 7 made the optical inclination functional film the lens configuration in the claim 1. Thus, since the optical inclination functional film was made into the lens configuration, the refractive-index difference in the interface of an exterior air layer decreases, and total reflection decreases very much.

[0016]

[Embodiments of the Invention] The light emitting diode of the form of implementation of the 1st of this invention is explained based on drawing 1 and drawing 2. Drawing 1 (a) is explanatory drawing in which the cross section of shell type light emitting diode and (b) showed the cross section of module type light emitting diode in the modification of the form of the 1st operation, and (c) showed the refractive index of the optical inclination functional film of the form of the 1st operation with the form of implementation of the 1st of this invention, and explanatory drawing in which drawing 2 shows a flux of light drawing principle.

[0017] As shown in drawing 1, the light-emitting-device section 1 is surrounded with the high refraction material which a refractive index is higher than an epoxy resin 5 at least, and has an insulating property so that this light emitting diode may be the structure which closed the light-emitting-device section 1 and a crevice may not be formed between the light-emitting-device sections 1, and the optical inclination functional film 2 with a refractive index which is gradually [continuously or] different by making the refractive index of material low is formed as it goes outside. In this case, in drawing 1 (a), DLC (Diamond Like Carbon) 3 is formed as a material which is insulating by high refraction focusing on the light-emitting-device section 1 prepared on the electrode 7, the exterior is accumulated to titanium oxide 4, epoxy resin 5, and magnesium 6 fluoride and an outside, and it is considering as the lens configuration. In drawing 1 (b), light-emitting-device section 1, DLC3, titanium oxide 4, epoxy resin 5, and magnesium 6 fluoride is formed like opening of the reflective frame 8. Moreover, one by one, a refractive index becomes low and the refractive index of the magnesium 6 fluoride besides \*\* is the lowest as are shown in drawing 1 (c), and the refractive index of DLC3 is the highest and goes to titanium oxide 4, an epoxy resin 5, and an outside.

[0018] The flux of light drawing principle of the light emitting diode of the above-mentioned composition is explained. If the refractive index of the semiconductor which constitutes the light-emitting-device section 1 is very high as shown in drawing 2 (a), and the matter B which has touched has a low refractive index, a critical angle will also be small and total reflection will tend to happen. Therefore, as shown in drawing 2 (b), the angle to which total reflection happens can be enlarged by wrapping the light-emitting-device section 1 in the matter A with a more high refractive index (quality of the material), and the flux of light drawing efficiency to the part exterior improves.

[0019] Since a difference with the refractive index of DLC3 which is the closure material which is in contact with a semiconductor with the very big refractive index which forms light emitting diode 1, and the light-emitting-device section 1 can be made small, it is hard coming to generate total reflection with the form of this operation about the light which comes from the interior of a semiconductor outside. For this reason, the light which comes out from the light-emitting-device section 1 can be effectively led to the exterior, the amount of total luminous flux improves, and the flux of light drawing efficiency from the light-emitting-device section 1 increases.

[0020] Furthermore, since material with a low refractive index forms the outside one by one, the refractive-index difference in the interface of the optical inclination functional film 2 which is lens formation material, and an exterior air layer is decreasing, total reflection decreases very much and the internal reflection loss of it within a resin is almost lost. Thereby, the flux of light loss to an exterior air layer from lens formation material decreases, and it can lead to the exterior effectively, without losing the flux of light taken out from the light-emitting-device section 1.

[0021] The light emitting diode of the form of implementation of the 2nd of this invention is explained based on drawing 3. In the form of implementation of the 2nd of this invention, drawing 3 (a) is the cross section of shell type light emitting diode, and (b) is the cross section of module type light emitting diode in the modification of the form of the 2nd operation.

[0022] As shown in drawing 3, at least, rather than the epoxy resin, it is the structure which closed the light-emitting-device section 1, and this light emitting diode has a high refractive index, with high refraction material with an insulating property, it surrounds the light-emitting-device section 1 so that the front face may be touched, and forms the periphery section with the material of a low refractive index by high refraction material. In this case, in drawing 3 (a), it applies to the light emitting diode 1 which formed DLC3 on the electrode 7 as a high refractive index material, and the exterior is made into the lens configuration using the epoxy resin 5. In drawing 3 (b), the light-emitting-device section 1, DLC3, and the epoxy resin 5 are formed like opening of the reflective frame 8. Moreover, the refractive index of DLC3 is higher than the refractive index of an epoxy resin 5. The flux of light drawing principle of the light emitting diode of the above-mentioned composition is the same as that of drawing 2.

[0023] Since a difference with the refractive index of DLC3 which is the closure material which is in contact with a semiconductor with the very big refractive index which forms the light-emitting-device section 1, and the light-emitting-device section 1 can be made small, it is hard coming to generate total reflection with the form of this operation about the light which comes from the interior of a semiconductor outside. For this reason, the light which comes out from the light-

light-emitting-device section 1 can be effectively led to the exterior, the amount of total luminous fluxes improves, and the flux of light drawing efficiency from the light-emitting-device section 1 increases.

[0024] The light-emitting diode of the form of implementation of the 3rd of this invention is explained based on drawing 4.

In the form of implementation of the 3rd of this invention, drawing 4 (a) is the cross section of shell type light-emitting diode, and (b) is the cross section of module type light-emitting diode in the modification of the form of the 3rd operation.

[0025] As shown in drawing 4, while this light-emitting diode is the structure which closed the light-emitting-device section 1 by the resin and a refractive index applies low plantar-flexion chip box material to a closure resin front face from a closure resin at least, it has at least one-fold [of this plantar-flexion chip box material] or more, and the outside makes the refractive index low. In this case, using magnesium fluoride as a plantar-flexion chip box material, this is applied to epoxy resin 10 front face which is a closure resin, and the lens configuration consists of drawing 4 (a). In drawing 4 (b), light-emitting-device section 1, epoxy resin 10, and magnesium fluoride 11 is formed like opening of the reflective frame 8. Moreover, the refractive index of magnesium fluoride is a low from the refractive index of an epoxy resin 10.

[0026] With the form of this operation, since material with a low refractive index forms the outside, the refractive-index difference in the interface of the material (magnesium fluoride) applied to the closure resin (epoxy resin 10) and an exterior air layer is decreasing, total reflection decreases very much and the internal reflection loss of it within a resin is almost lost. Thereby, reduction of the flux of light loss to an exterior air layer from lens formation material can be aimed at, and a light guide can be effectively carried out to the exterior, without losing the flux of light taken out from the light-emitting-device section 1. Moreover, a surface application is possible at a low cost, and cost performance is high.

[0027] In addition, although the optical inclination functional film 2 was made into four layer structures with the form of the 1st operation, what is necessary is just three or more layers. Moreover, except this is sufficient although DLC was used as a high refraction material. With the form of the 3rd operation, although magnesium fluoride was used as a low refraction material, except this is sufficient.

[0028]

[Effect of the Invention] According to the light-emitting diode of this invention according to claim 1, so that a crevice may not be formed between the light-emitting-device sections. At least, rather than an epoxy resin, a refractive index is high and the aforementioned light-emitting-device section is surrounded with high refraction material with an insulating property. Since the optical inclination functional film with a refractive index which is gradually [continuously or] different by making the refractive index of material low was formed as it went outside, a difference with the refractive index of the material which is in contact with a semiconductor with the very big refractive index which forms the light-emitting-device section, and the light-emitting-device section can be made small. For this reason, the light which it is hard coming to generate total reflection about the light which comes from the interior of a semiconductor outside, and comes out from the light-emitting-device section can be effectively led to the exterior, the amount of total luminous fluxes improves, and the flux of light drawing efficiency from the light-emitting-device section increases.

[0029] A difference with the refractive index of the material which according to the light-emitting diode of this invention according to claim 2 is in contact with a semiconductor with the very big refractive index which forms the light-emitting-device section, and the light-emitting-device section from the epoxy resin at least since the light-emitting-device section was surrounded with the high refraction material which a refractive index is high and has an insulating property so that a front face might be touched, and the periphery section was formed with the material of a refractive index lower than high refraction material can be made small. For this reason, the light which it is hard coming to generate total reflection about the light which comes from the interior of a semiconductor outside, and comes out from the light-emitting-device section can be effectively led to the exterior, the amount of total luminous fluxes improves, and the flux of light drawing efficiency from the light-emitting-device section increases.

[0030] According to the light-emitting diode of this invention according to claim 3, while a refractive index applies low plantar-flexion chip box material to a closure resin front face from a closure resin at least, since it has at least one-fold or more and the outside made the refractive index low, this plantar-flexion chip box material can inject now to the exterior more light which was carrying out total reflection to the exterior air layer by the interface of a closure resin, and its amount of total luminous fluxes improves. Moreover, since a surface application at a simple process is possible for plantar-flexion chip box material, cost performance is high.

[0031] Since high refraction material is DLC, light-emitting diode according to claim 4 can be used as a material in which a refractive index has insulation highly.

[0032] In a claim 5, since the epoxy resin was formed in the outside of high refraction material, the light which comes out from the light-emitting-device section can be led outside effectively.

[0033] A refractive index can be made low as it goes outside by the claim 6, since the laminating of the titanium-chloride, epoxy resin, and magnesium fluoride was carried out to the outside of high refraction material, and the light which comes out from the light-emitting-device section can be drawn outside effectively.

[0034] In a claim 7, since the optical inclination functional film was made into the lens configuration, the refractive-index difference in the interface of an exterior air layer decreases, and total reflection decreases very much.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] (a) is explanatory drawing in which the cross section of shell type light emitting diode and (b) showed the cross section of module type light emitting diode in the modification of the gestalt of the 1st operation, and (c) showed the refractive index of the optical inclination functional film of the gestalt of the 1st operation with the gestalt of implementation of the 1st of this invention.

[Drawing 2] It is explanatory drawing showing a flux of light drawing principle.

[Drawing 3] In the gestalt of implementation of the 2nd of this invention, (a) is the cross section of shell type light emitting diode, and (b) is the cross section of module type light emitting diode in the modification of the gestalt of the 2nd operation.

[Drawing 4] In the gestalt of implementation of the 3rd of this invention, (a) is the cross section of shell type light emitting diode, and (b) is the cross section of module type light emitting diode in the modification of the gestalt of the 3rd operation.

[Drawing 5] It is the conceptual diagram showing the conventional shell type light emitting diode.

[Drawing 6] The perspective diagram in which (a) shows the conventional module type light emitting diode, and (b) are the important section expanded sectional view.

[Description of Notations]

1 Light-Emitting-Device Section

2 Optical Inclination Functional Film

3 DLC

4 Titanium Oxide

5 Ten Epoxy resin

6 11 Magnesium fluoride

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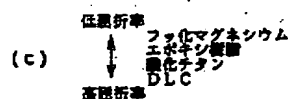
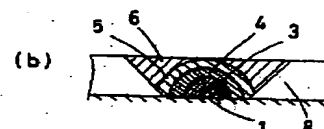
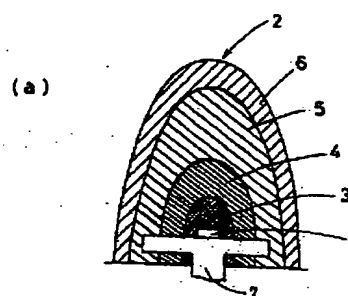
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(54) 【発明の名称】 発光ダイオード

(57) 【要約】

【課題】 発光素子部の半導体内部からの光束の損失を抑え、封止樹脂外部へ有効に導出する。

【解決手段】 発光素子部 1 を封止した発光ダイオードであって、発光素子部 1 との間に隙間が形成されないように、少なくともエポキシ樹脂 5 よりも屈折率が高く、絶縁特性を持つ高屈折材料 (DLC 3) で発光素子部 1 を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜 2 を形成した。これにより、発光素子部 1 を形成している屈折率が非常に大きな半導体と発光素子部 1 に接している材質の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部 1 から出てくる光を有効に外部へ導くことができ、全光束量が向上する。



- 1…発光素子部 6…フッ化マグネシウム  
3…DLC (Diamond Like Carbon) 7…電極  
4…酸化チタン 8…反射層  
5…エポキシ樹脂

## 【特許請求の範囲】

【請求項 1】 発光素子部を封止した発光ダイオードであって、前記発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成したことを特徴とする発光ダイオード。

【請求項 2】 発光素子部を封止した発光ダイオードであって、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を表面に接するように囲み、前記高屈折材料より低い屈折率の材料で外周部を形成したことを特徴とする発光ダイオード。

【請求項 3】 発光素子部を樹脂で封止した発光ダイオードであって、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも 1 重以上有し、外側ほど屈折率を低くしたことを特徴とする発光ダイオード。

【請求項 4】 高屈折材料は DLC である請求項 1 または 2 記載の発光ダイオード。

【請求項 5】 高屈折材料の外側にエポキシ樹脂を形成した請求項 2 記載の発光ダイオード。

【請求項 6】 高屈折材料の外側に塩化ナタン、エポキシ樹脂、フッ化マグネシウムを積層した請求項 1 記載の発光ダイオード。

【請求項 7】 光学的傾斜機能膜をレンズ形状にした請求項 1 記載の発光ダイオード。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 この発明は、発光素子部から光の取出し効率を向上させる封止構造を有する発光ダイオードに関するものである。

## 【0002】

【従来の技術】 図 5 は従来の砲弾型発光ダイオードを示す概念図、図 6 (a) は従来のモジュール型発光ダイオードを示す斜視図、(b) はその要部拡大断面図である。図 5 に示すように、従来の発光ダイオードでは、発光素子部 50 をエポキシ樹脂 51 で封止している。また、図 6 では反射枠 52 の開口部に発光素子部 50 を配置してエポキシ樹脂 51 で封止している。

## 【0003】

【発明が解決しようとする課題】 しかしながら、上記従来の発光ダイオードでは、発光素子部 50 を形成している半導体の屈折率は非常に大きく、発光素子部 50 に接している封止材料（エポキシ樹脂）の屈折率との差が大きいため、半導体内部での発光については全反射が生じ易く、光束の取出し効率が低い欠点があった。また、エポキシ樹脂外へ射出される光は、ある角度より大きなものは全反射され内部で損失を生じていた。

【0004】 したがって、この発明の目的は、上記のよ

うな従来の問題点を考慮して、発光素子部の半導体内部からの光束の損失を抑えるための発光ダイオード封止構造および一度素子から取り出された光側を封止樹脂外部へ有効に導出する発光ダイオードを提供することである。

## 【0005】

【課題を解決するための手段】 上記課題を解決するためにこの発明の請求項 1 記載の発光ダイオードは、発光素子部を封止した発光ダイオードであって、前記発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成した。

【0006】 一般に発光素子部を構成している半導体の屈折率は非常に高く、接している物質が屈折率が低ければ臨界角も小さく全反射が起こり易い。そのため、より屈折率の高い物質で発光素子部を包むことで、全反射の起こる角度を大きくでき、その分外部への光束取出し効率が向上する。

【0007】 請求項 1 では、発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上する。

【0008】 請求項 2 記載の発光ダイオードは、発光素子部を封止した発光ダイオードであって、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を表面に接するように囲み、高屈折材料より低い屈折率の材料で外周部を形成した。

【0009】 このように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部を表面に接するように囲み、高屈折材料より低い屈折率の材料で外周部を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上する。

【0010】 請求項 3 記載の発光ダイオードは、発光素子部を樹脂で封止した発光ダイオードであって、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも 1 重以上有し、外側ほど屈折率を低くした。



【0011】このように、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも1重以上有し、外側ほど屈折率を低くしたので、外部空気層と封止樹脂の界面で全反射していた光をより多く外部へ射出できるようになり、全光束量が向上する。

【0012】請求項4記載の発光ダイオードは、請求項1または2において、高屈折材料はDLCである。このように、高屈折材料はDLC (Diamond Like Carbon) であるので、屈折率が高く絶縁性のある材料として用いることができる。

【0013】請求項5記載の発光ダイオードは、請求項2において、高屈折材料の外側にエポキシ樹脂を形成した。このように、高屈折材料の外側にエポキシ樹脂を形成したので、発光素子部から出てくる光を有効に外部に導くことができる。

【0014】請求項6記載の発光ダイオードは、請求項1において、高屈折材料の外側に塩化チタン、エポキシ樹脂、フッ化マグネシウムを積層した。このように、高屈折材料の外側に塩化チタン、エポキシ樹脂、フッ化マグネシウムを積層したので、外側へいくに従い屈折率を低くすることができ、発光素子部から出てくる光を有効に外部に導くことができる。

【0015】請求項7記載の発光ダイオードは、請求項1において、光学的傾斜機能膜をレンズ形状にした。このように、光学的傾斜機能膜をレンズ形状にしたので、外部空気層の界面での屈折率差は少なくなり、全反射は非常に少なくなる。

【0016】

【発明の実施の形態】この発明の第1の実施の形態の発光ダイオードを図1および図2に基づいて説明する。図1(a)はこの発明の第1の実施の形態で砲弾型発光ダイオードの断面図、(b)は第1の実施の形態の変形例でモジュール型発光ダイオードの断面図、(c)は第1の実施の形態の光学的傾斜機能膜の屈折率を示した説明図、図2は光束取出し原理を示す説明図である。

【0017】図1に示すように、この発光ダイオードは、発光素子部1を封止した構造で、発光素子部1との間に隙間が形成されないように、少なくともエポキシ樹脂5よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部1を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜2を形成している。この場合、図1(a)では電極7上に設けた発光素子部1を中心に、高屈折で絶縁性のある材料としてDLC (Diamond Like Carbon) 3を形成し、その外部を酸化チタン4、エポキシ樹脂5、フッ化マグネシウム6と外側へ積み上げ、レンズ形状としている。図1(b)では反射枠8の開口部に同様に発光素子部1、DLC 3、酸化チタン4、エポキシ樹脂5、フッ化マグネシウム6を形成して

いる。また、図1(c)に示すように、DLC 3の屈折率が最も高く、酸化チタン4、エポキシ樹脂5と外側へいくに従い順次屈折率が低くなり、最外のフッ化マグネシウム6の屈折率が最も低くなっている。

【0018】上記構成の発光ダイオードの光束取出し原理について説明する。図2(a)に示すように発光素子部1を構成している半導体の屈折率は非常に高く、接している物質Bが屈折率が低ければ臨界角も小さく全反射が起こり易い。そのため、図2(b)に示すようにより屈折率の高い物質(材質)Aで発光素子部1を包むことで、全反射の起こる角度を大きくでき、その分外部への光束取出し効率が向上する。

【0019】この実施の形態では、発光ダイオード1を形成している屈折率が非常に大きな半導体と発光素子部1に接している封止材料であるDLC 3の屈折率との差を小さくできるため、半導体内部から外へ出る光について全反射が生じにくくなる。このため、発光素子部1から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部1からの光束取出し効率が増加する。

【0020】さらに、順次屈折率の低い材料が外側を形成しているため、レンズ形成材である光学的傾斜機能膜2と外部空気層の界面での屈折率差は少なくなることで、全反射は非常に少なくなり樹脂内での内部反射損失がほとんどなくなる。これにより、レンズ形成材から外部空気層への光束損失が低減し、発光素子部1より取出された光束を損失することなく、有効に外部へ導くことができる。

【0021】この発明の第2の実施の形態の発光ダイオードを図3に基づいて説明する。図3(a)はこの発明の第2の実施の形態で砲弾型発光ダイオードの断面図、(b)は第2の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【0022】図3に示すように、この発光ダイオードは、発光素子部1を封止した構造で、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部1をその表面に接するように囲み、高屈折材料により低い屈折率の材料で外周部を形成している。この場合、図3(a)では高屈折材料としてDLC 3を電極7上に設けた発光ダイオード1へ塗布し、その外部をエポキシ樹脂5を用いてレンズ形状としている。図3(b)では反射枠8の開口部に同様に発光素子部1、DLC 3、エポキシ樹脂5を形成している。また、DLC 3の屈折率はエポキシ樹脂5の屈折率より高い。上記構成の発光ダイオードの光束取出し原理は図2と同様である。

【0023】この実施の形態では、発光素子部1を形成している屈折率が非常に大きな半導体と発光素子部1に接している封止材料であるDLC 3の屈折率との差を小さくできるため、半導体内部から外へ出る光について全

反射が生じにくくなる。このため、発光素子部 1 から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部 1 からの光束取出し効率が增加する。

【0024】この発明の第 3 の実施の形態の発光ダイオードを図 4 に基づいて説明する。図 4 (a) はこの発明の第 3 の実施の形態で砲弾型発光ダイオードの断面図、(b) は第 3 の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【0025】図 4 に示すように、この発光ダイオードは、発光素子部 1 を樹脂で封止した構造で、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも 1 重以上有し、外側ほど屈折率を低くしている。この場合、図 4 (a) では低屈折材料としてフッ化マグネシウムを用い、これを封止樹脂であるエポキシ樹脂 10 表面へ塗布してレンズ形状を構成している。図 4 (b) では反射枠 8 の開口部に同様に発光素子部 1、エポキシ樹脂 10、フッ化マグネシウム 11 を形成している。また、フッ化マグネシウム 11 の屈折率はエポキシ樹脂 10 の屈折率より低い。

【0026】この実施の形態では、屈折率の低い材料が外側を形成しているため、封止樹脂 (エポキシ樹脂 10) に塗布した材料 (フッ化マグネシウム 11) と外部空気層の界面での屈折率差は少なくなることで、全反射は非常に少なくなり樹脂内での内部反射損失がほとんどなくなる。これにより、レンズ形成材から外部空気層への光束損失の低減を図ることができ、発光素子部 1 より取出された光束を損失することなく、有効に外部へ導光できる。また、低コストで表面塗布可能でありコストパフォーマンスが高い。

【0027】なお、第 1 の実施の形態では、光学的傾斜機能膜 2 を 4 層構造としたが、3 層以上であればよい。また、高屈折材料として DLC を用いたがこれ以外でもよい。第 3 の実施の形態では、低屈折材料としてフッ化マグネシウムを用いたがこれ以外でもよい。

【0028】

【発明の効果】この発明の請求項 1 記載の発光ダイオードによれば、発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部からの光束取出し効率が增加する。

【0029】この発明の請求項 2 記載の発光ダイオード

によれば、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部を表面に接するように囲み、高屈折材料より低い屈折率の材料で外周部を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部からの光束取出し効率が增加する。

【0030】この発明の請求項 3 記載の発光ダイオードによれば、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも 1 重以上有し、外側ほど屈折率を低くしたので、外部空気層と封止樹脂の界面で全反射していた光をより多く外部へ射出できるようになり、全光束量が向上する。また、低屈折材料は簡易な工程で表面塗布可能であるので、コストパフォーマンスが高い。

【0031】請求項 4 記載の発光ダイオードは、高屈折材料は DLC であるので、屈折率が高く絶縁性のある材料として用いることができる。

【0032】請求項 5 では、高屈折材料の外側にエポキシ樹脂を形成したので、発光素子部から出てくる光を有効に外部に導くことができる。

【0033】請求項 6 では、高屈折材料の外側に塩化チタン、エポキシ樹脂、フッ化マグネシウムを積層したので、外側へいくに従い屈折率を低くすることができ、発光素子部から出てくる光を有効に外部に導くことができる。

【0034】請求項 7 では、光学的傾斜機能膜をレンズ形状にしたので、外部空気層の界面での屈折率差は少なくなり、全反射は非常に少なくなる。

【図面の簡単な説明】

【図 1】(a) はこの発明の第 1 の実施の形態で砲弾型発光ダイオードの断面図、(b) は第 1 の実施の形態の変形例でモジュール型発光ダイオードの断面図、(c) は第 1 の実施の形態の光学的傾斜機能膜の屈折率を示した説明図である。

【図 2】光束取出し原理を示す説明図である。

【図 3】(a) はこの発明の第 2 の実施の形態で砲弾型発光ダイオードの断面図、(b) は第 2 の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【図 4】(a) はこの発明の第 3 の実施の形態で砲弾型発光ダイオードの断面図、(b) は第 3 の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【図 5】従来の砲弾型発光ダイオードを示す概念図である。

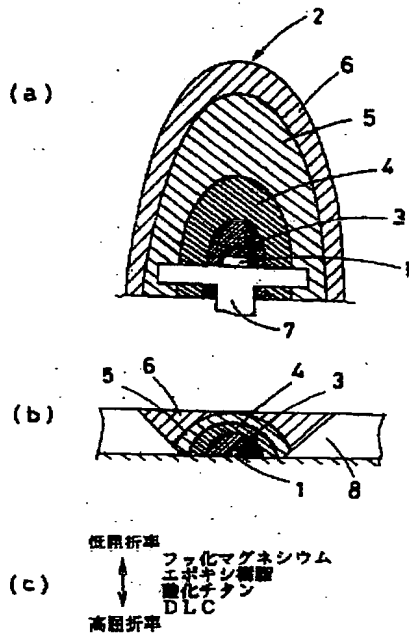
【図 6】(a) は従来のモジュール型発光ダイオードを示す斜視図、(b) はその要部拡大断面図である。

【符号の説明】

- 1 発光素子部  
2 光学的傾斜機能膜  
3 DLC

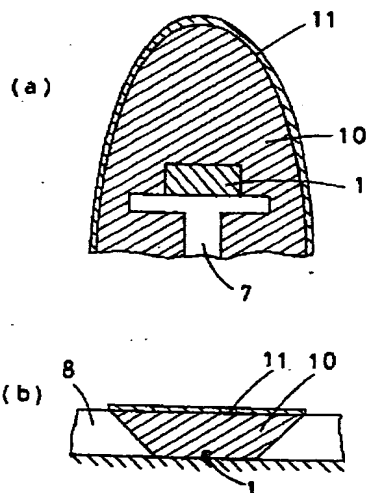
- 4 酸化チタン  
5, 10 エポキシ樹脂  
6, 11 フッ化マグネシウム

【図1】



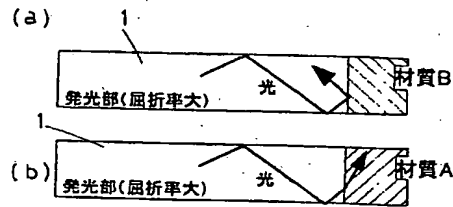
- 1…発光素子部      6…フッ化マグネシウム  
3…DLC (Diamond Like Carbon)      7…電極  
4…酸化チタン      8…反射層  
5…エポキシ樹脂

【図4】

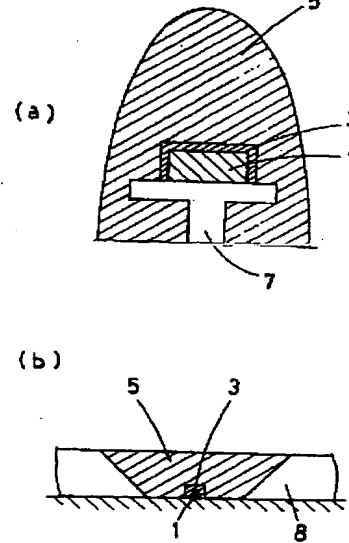


- 1…発光素子部      10…エポキシ樹脂  
7…電極      11…フッ化マグネシウム  
8…反射層

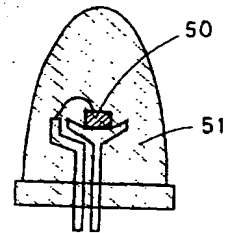
【図2】



【図3】

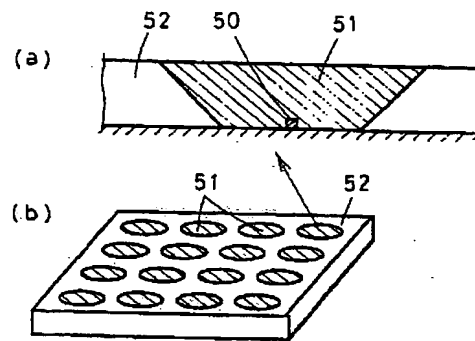


【図5】



- 50…発光素子部  
51…エポキシ樹脂

【図6】



50...発光素子部  
51...エポキシ樹脂  
52...反射層

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